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Dated

10th July 2000



## Patents Form 1/77

Patents Act 1977  
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The  
Patent  
Office  
- 9 JUN 1999

EFFECTIVE  
09JUN99 E453194-1 D02838  
P01/7700 0.00 - 9913357.1

## Request for grant of a patent

(See the notes on the back of this form. You can also get  
an explanatory leaflet from the Patent Office to help  
you fill in this form)

The Patent Office

Cardiff Road  
Newport  
Gwent NP9 1RH

## 1. Your reference

WN/NV/ATMOS.1

## 2. Patent application number

(The Patent Office will fill in this part)

9913357.1

## 3. Full name, address and postcode of the or of each applicant (underline all surnames)

Atmospheric Solutions Limited  
Unit 23Y, Bond's Mill Estate,  
Bristol Road, Stonehouse, Gloucestershire  
GL10 3RF

Patents ADP number (if you know it)

If the applicant is a corporate body, give the  
country/state of its incorporation

United Kingdom

07675762001

SD

## 4. Title of the invention

Reduction of Ozone in an Enclosed  
Environment

## 5. Name of your agent (if you have one)

"Address for service" in the United Kingdom  
to which all correspondence should be sent  
(including the postcode)

Wynne-Jones, Laine and James  
22 Rodney Road  
Cheltenham, Gloucestershire  
GL50 1JJ

Patents ADP number (if you know it)

1792001 ✓

## 6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)Date of filing  
(day / month / year)

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## 7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

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## 8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

c) any named applicant is a corporate body.

See note (d))

**Patents Form 1/77**

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Description

16 ✓

Claim(s)

-

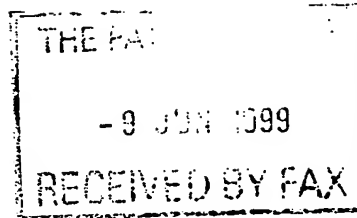
Abstract

-

Drawing(s)

6

/ 5M



10. If you are also filing any of the following, state how many against each item.

Priority documents

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Translations of priority documents

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Statement of inventorship and right to grant of a patent (Patents Form 7/77)

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Request for preliminary examination and search (Patents Form 9/77)

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Request for substantive examination (Patents Form 10/77)

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Any other documents

(please specify)

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11.

I/Wc request the grant of a patent on the basis of this application.

Signature

Date 9-6-99

Wynne-Jones, Lainé and James

12. Name and daytime telephone number of person to contact in the United Kingdom

W.J. Newell - Tel: 01242 515807

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Reduction of Ozone in an Enclosed Environment

5 This invention relates to the reduction of ozone in  
an enclosed environment.

10 The rising number of asthma sufferers in the Western  
World and in particular in the United Kingdom is a matter  
of great concern and much research has been done to  
understand both the causes of the disease and the  
mechanisms which trigger the onset of an attack.

15 It is known from published papers by RB Devlin et al  
("Health Effects of Ozone", Science and Medicine, May/June  
1997, pages 8 to 17) and by N A Molfino et al ("Effect of  
Low Concentrations of Ozone on Inhaled Allergen Responses  
in Asthmatic Subjects", The Lancet, Volume 338, No. 8761,  
27 July 1991, pages 199 to 203) that relatively low levels  
of ozone, similar to those commonly occurring in urban  
areas, can increase the likelihood of asthma attacks.

20 Ozone occurs naturally and can for example be caused  
by thunder storms. Ozone is also created by ultraviolet  
light. Further, in an office environment levels of ozone  
can rise significantly due to the ozone produced by  
electrostatic printing equipment such as laser printers  
and photocopiers.

25 The problem of reducing the level of ozone produced  
by apparatus such as a photocopier or laser printer has

been addressed in US 4,853,735. It has been recognised that such devices are a principle source of ozone in an office environment and thus this document attempts to deal with the problem by reducing the level of ozone near the source i.e. within the apparatus. In order to achieve this a volatile ozone removing agent comprising a mixture of a terpenoid and a glycol family material is used. An ozone removing device is located within the photocopier machine and is designed to provide a controlled flow rate of ozone removing agent. With this arrangement, there are several disadvantages. Firstly the location of the ozone removing agent within the confines of the photocopier means that it will be subject to temperature ranges well outside the normal range of room temperatures and so the evaporation rates will vary accordingly. Another difficulty is that the ozone removing device is a fixture to the photocopier and so will tend to be regarded as a replaceable item for the photocopier, which will require installation, and the device will be priced accordingly. Furthermore, the device requires the use of glycol which is a corrosive material. In addition, ozone is a naturally unstable compound and so, outside working hours, the ozone levels in a room will fall to a baseline level, and thus any evaporation of ozone reducing agent outside working hours is effectively wasted.

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US Patent 5,567,416 discloses a slow-volatizing terpenoid composition comprising a mixture of a terpenoid and an anti-oxidant absorbed into a polymeric network material. There are several difficulties associated with this proposal; the substance involved has a relatively low boiling point and uses an additive to raise the flash point of the composition. The additive is dichloropentafluoropropane (HCFC225) which is thought by some to be environmentally undesirable. Furthermore the composition includes an anti-oxidant which is intended to prevent oxidation of the limonene. Since ozone is a powerful oxidizing agent, it is believed that this anti-oxidant may inhibit the reaction of the terpene with ozone.

10

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US Patent 5,256,377 describes an ozone removing device which again is primarily for use in photocopiers. A terpenoid is absorbed onto a support material and subjected to forced ventilation by means of a fan at the outlet of a photocopier.

20

Japanese Patent Documents JP 1310366, JP 2090184 and JP 62155927 each disclose arrangements in which an ozone removing device is located in or adjacent the exhaust duct of a photocopier.

25

Accordingly, it is an aim of this invention to provide a passive method and apparatus for controlling the level of ozone in a room or other generally enclosed

environment which does not rely on heating or forced ventilation and furthermore which provides a controlled release of ozone reducing agent at a rate commensurate with maintaining the ozone levels in a room housing a photocopier and/or a laser printer at acceptable levels, without requiring the use of potentially harmful additives, so as to make effective use of the ozone reducing agent to provide an extended ozone-reducing effect.

Accordingly, in one aspect, this invention provides a method of reducing the level of ozone in a generally enclosed environment, which comprises releasing a terpenoid vapour or a mixture of terpenoid vapours into the environment at a controlled rate.

In studies conducted by the Applicants it has been found that a useful control effect is achieved by releasing the terpenoid vapour at a rate of between 40 and 120mg per hour, more preferably between 60 and 100mg per hour, and ideally about 80mg per hour. The Applicants have determined that a room may be dosed with terpenoid compounds at a required given evaporation rate by careful balancing of the emission characteristics of the support (e.g. void volume, pore size, particulate size etc.) with the evaporation characteristics of the terpenoid compound (determined by, e.g. the boiling point temperature) and the amount of terpenoid to be stored. Thus in one



proffered example linalool is impregnated into an emission element of Vyon E grade material, and, for the size of emission element used an emission rate of about 80 mg/hour is achieved. More volatile compounds (i.e. with lower boiling points) would need to be used with a less emissive material.

It is preferred for said terpenoid vapour to be released by evaporation from an emission element of absorbent material. The evaporation preferably takes place at normal room temperature (17° C to 25° C) (i.e. no heating is required), such that the evaporation rate, and thus working life of the emission element can be predicted. Likewise evaporation and permeation of the vapour throughout the generally enclosed environment preferably occurs in natural, unforced ventilation (i.e. no fan or confining duct is used).

Preferably said emission element is located in a container configurable between an open position, in which the element is exposed to the ambient atmosphere and a closed position in which said element is generally enclosed within a housing.

Preferably the emission element comprises a porous synthetic polymer structure. The polymer lattice may conveniently be produced by moulding and/or sintering a starting material comprising a synthetic thermo-plastic polymer in particulate form.

In one embodiment, the starting material is a high density polyethylene in which at least 80% by weight of the particles have a particle size within the range of from 1 to 500 micron.

5 Naturally the size and weight of the emission element depend at least partly on the size of the room to be treated, the volatility of the absorbed liquid and the porosity of the element. In one example said emission element, before absorption of said terpenoid, may  
10 typically weigh from 5 to 15 grams. The emission element preferably contains between 10 and 20 grams of terpenoid liquid, and ideally about 15 grams thereof.

The void volume of the emission element may conveniently lie in the range of from 25% to 70% and more  
15 preferably between 30% and 55%. In a particular example, the average pore size of the emission element is between 10 and 100 microns.

Preferably the or each terpenoid comprises a terpene or a carotenoid. At least one of the terpenoid compounds  
20 preferably comprises a compound extracted from a plant, or a synthesised compound corresponding to a constituent of a plant extract. Plant extracts that we have found to be suitable are lavender oil, orange oil, grapefruit oil, lime oil, myrtle oil, coriander oil, tea tree oil,  
25 elecampane oil, juniper oil, dill oil, lemon oil, elemi oil, spanish sage oil, cypress oil, pine needle oil, lemon

balm (melissa) oil, nutmeg oil, ylang ylang oil, basil oil, grapeseed oil, whilst suitable natural or synthesised compounds comprise  $\alpha$  phellandrene,  $\alpha$  humulene,  $\alpha$  terpinene, limonene,  $\alpha$  pinene,  $\beta$  caryophyllene, linalool, linalyl acetate, and myrcene.

To enhance safety without requiring the use of modifiers etc., the flash point of the terpenoid compound is preferably greater than 60° C.

Of the compounds set out above we have found linalool to be particularly effective in terms of reaction with ozone and a sustained evaporation rate.

In another aspect, this invention provides the use of at least one of lavender oil, orange oil, grapefruit oil, lime oil, myrtle oil, coriander oil, tea tree oil, elecampane oil, juniper oil, dill oil, lemon oil, elemi oil, spanish sage oil, cypress oil, pine needle oil, lemon balm (melissa) oil, nutmeg oil, ylang ylang oil, basil oil, grapeseed oil,  $\alpha$  phellandrine,  $\alpha$  humulene,  $\alpha$  terpinene, limonene,  $\alpha$  pinene,  $\beta$  caryophyllene, linalool, linalyl acetate, or myrcene for the removal of ozone in a generally enclosed environment.

In another aspect, this invention provides apparatus for removing ozone in a generally enclosed environment, said apparatus comprising an emission element of absorbent material impregnated with at least one terpenoid compound

located within a container which in use allows free circulation of vapour into said environment.

5 Preferably said container is reconfigurable between an open operational configuration, in which vapour evaporating from said emission element may dissipate into said environment, and a closed configuration in which said emission element is enclosed.

10 Advantageously, said container comprises an inner housing having perforate walls, said inner housing being movably mounted with respect to an outer housing. Preferably said emission element comprises a porous polymer substrate impregnated with a terpenoid compound. Said terpenoid compound may advantageously comprise linalool, preferably without additives. Preferably said  
15 emission element contains between 10 and 20 grams of linalool. Preferably said emission element has a void volume of between 25% and 70% and an average pore size of between 10 and 100 microns.

20 Whilst the invention has been described above it extends to any inventive combination of the features set out above or in the following description.

25 The invention may be performed in various ways, and an embodiment thereof and certain test results will now be described in detail, reference being made to the accompanying drawings, in which:-

Figure 1 is a front plan view of an ozone removing apparatus in accordance with the invention, in an open position;

5 Figure 2 is a side view, taken on the left hand side of the apparatus of Figure 1;

Figure 3 is a graph showing the decay of the concentration of ozone in a closed environment (i) naturally and (ii) when an ozone reducing device in accordance with this invention is present, and

10 Figure 4(a) to 4(d) are comparative graphs showing the build up of ozone in a closed environment containing an ozone generator (i) with natural decay only (ii) with a first example of this invention and (iii) with a second example of this invention, after 72, 96, 120 and 168 hours respectively.

15 Referring to Figures 1 and 2, a dispenser comprises a perforated housing 10 containing an emission disk or element 12 made of a sheet of an absorbent porous polymer lattice structure available under the Trade Name Vyon Grade E from Porvair Limited, Norfolk, UK. The disk was approximately 90mm in diameter, 5mm thick, and weighed approximately 10 grams. The emission element 12 was left to stand in a dish of a terpenoid (in this example linalool) until saturated. The emission element took up about 15 grams of linalool. The porosity of the support was selected having regard to the volatility of the

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25

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linalool so that, under normal room temperature conditions, with natural ventilation, the emission element emitted about 80mg of linalool per hour. This gave a theoretical maximum life of 187.5 hours which is equivalent to approximately one month of working hours in a typical office room containing a photocopier.

10

The perforated housing 10 is pivotally mounted within an outer, imperforate housing 14 having a pivotal attachment, so that the apparatus can be moved between an open position (as shown in Figure 1) and a closed position in which the container is enclosed substantially wholly within the housing 14 thus preventing release of the linalool.

15

Referring now to Figure 3, this is a graph showing the natural decay rate of ozone and the decay rate with a product in accordance with the invention. In this instance the product included a rectangular emission element of Vyon F material, of 90mm x 70mm and 4.75mm thickness, impregnated with about 15 grams of linalool.

20

It will be seen that the time taken for the ozone concentration to reduce naturally to 50 ppb is over 1000 seconds, whereas with the example of the invention the ozone concentration reduces to 50 ppb in about 260 seconds.

25

Referring now to Figures 4a to 4d, these are graphs showing the ozone concentration or build up in a closed

test environment when an ozone generator is turned on. On each graph there are three traces; the ozone concentration without any ozone removing agent, and the ozone concentration with two examples of the invention (Vyon E#1 and Vyon E#2). In addition to this, the sequence of Figures 4(a) to 4(d) show the characteristics of two examples of the invention after 72, 96, 120 and 168 hours respectively. The examples of the invention comprised Vyon E grade disks 90mm in diameter and 4.75 mm thick, with an original impregnation of about 15gms of linalool. These graphs show individually that the examples of the invention maintain the ozone concentration at a peak level of below about 75 ppb and generally at about 50 ppb or lower, whereas without the ozone-removing devices the ozone concentration would reach over 200 ppb. The graphs as a set show that the examples of the invention retain their ozone-removing effect substantially unchanged for at least 168 hours. Assuming that the devices are closed outside working hours and that there is no significant evaporation when closed, this means that the examples will continue to be highly effective for at least 21 working days.

As noted above the apparatus emits linalool vapour at a rate of about 80mg per hour, (when the device is open). This emission rate is substantially constant over the life of the pad. Our studies have shown that, in a typical

office environment including a photocopier and a laser jet, about 10mg of ozone may be produced per hour. Giv  
the relative molecular weights of linalool and ozone, 32mg  
of linalool per hour would be required, assuming that each  
5 molecule of linalool reacted with an ozone molecule. In  
practice an excess of linalool is required and for this  
purpose a factor of between 2 and 3 has been found to work  
reasonably well. Accordingly it has been found that an  
evaporation rate of linalool of between 60 to 100mg per  
10 hour provides good performance.

These emission rates, together with the sustained  
extended emission life achieved through careful matching  
of the properties of the oil with the emission element,  
provide a particularly effective solution to the problem  
15 of maintaining low ozone levels in an office environment.  
Furthermore, the active agent in the material can be  
derived from natural sources or be a synthetic derivation  
thereof, and so is environmentally friendly without  
requiring additives, which may themselves be seen as  
20 environmentally unfriendly, or other substances which may  
add to the material or manufacturing cost of the device.

Whilst the above embodiment uses linalool on a  
absorbent pad of Vyon E material, it will of course be  
appreciated that other terpenoids may be used with other  
25 emission elements.



5

The tables below illustrate the terpenoid compounds which have been tested for their effectiveness in carrying out the present invention. In Table 1, the compounds are shown ranked in order of reactivity, showing the time taken to reduce the concentration of ozone in a standard test atmosphere (100ppb ozone) to 50% of the standard concentration (t100-50) and to 20% of the standard concentration (t100-20).

10

The tests were carried out with a grade of Vyong material which emitted at a higher rate than Vyong 'E', initially impregnated with 5ml of linalool, but the results are a good illustration of the relative performance of the substances.

TABLE 1

Essential Oil and Chemical Reactivity

Essential Oil/Chemical	t100-50 (sec)	t100-20 (sec)
Tangerine	112	226
Myrcene	122	261
Mandarin	122	280
Limonene	131	292
Fir needle	132	336
Melissa	163	407
Carrot seed	169	404
Linalool	185	387
Bay	195	526
Dill seed	195	587
Myrtle	200	506
Fennel	201	449
Ravensara	239	567
May Chang	250	524
Inula	260	544
Petitgrain	265	647
Cajeput	276	723
$\beta$ -pinene	288	653
Coriander	292	571
Manuka	320	756
Clary Sage	320	714
Ho Wood	325	866
Eucalyptus	328	664
Spearmint	329	776
Citronella	330	>1000
$\beta$ -Caryophyllene	344	645

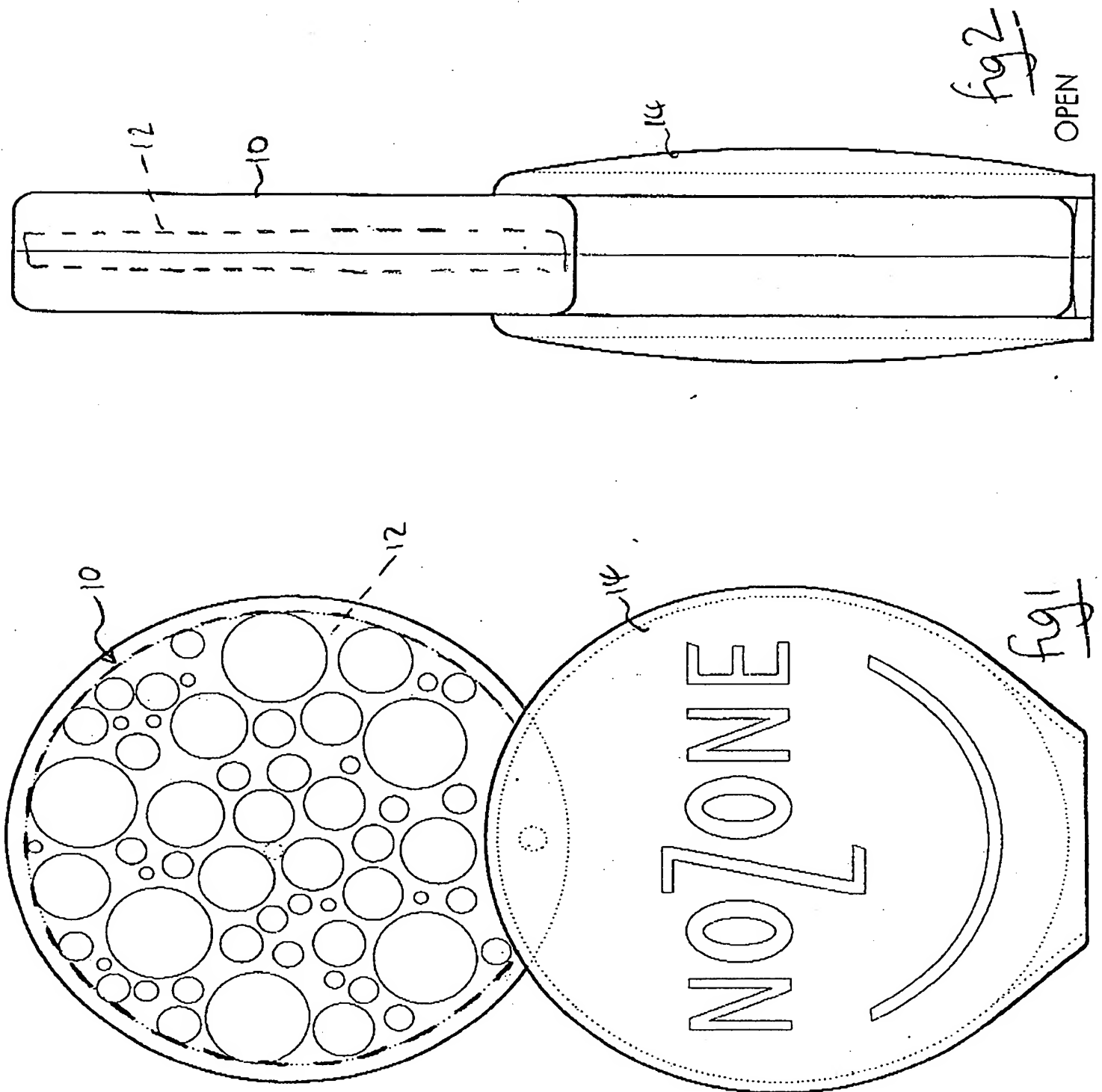
TABLE 1 (cont.1)

Sage	350	>1000
Peppermint	352	730
Ginger	354	814
Niaouli	359	741
Lynalyl acetate	375	736
Myrrh	384	839
Palmarosa	388	892
Spanish sage	392	>1000
Thyme	392	>1000
Geraniol	399	>1000
Valerian	407	785
Cardamon	409	992
Oregano	423	954
Patchouli	460	>1000
Friars Balsam	468	>1000
Terpineol	474	
Nerol	486	>1000
Cinnamon	503	>1000
Citronellol	530	>1000
Ylang Ylang Extra	531	>1000
Geranium	538	>1000
Ylang Ylang	539	>1000
Cedar Wood	539	>1000
Jasmine	584	>1000
Amyris	628	>1000
Citral	647	>1000
Soya	667	>1000
Farnesol	669	>1000
Coconut	673	>1000
Hop Oil	688	>1000

TABLE 1 (cont.2)

Oleic acid	688	>1000
Carrot tissue	691	>1000
Almond Oil	731	>1000
Clove bud	738	>1000
Hypericum	741	>1000
Hop Extract	742	>1000
Calendula	749	>1000
Borage	768	>1000
Sunflower	771	>1000
Apricot Kernal	784	>1000
Rosehip	796	>1000
Grape Seed	808	>1000
Evening Primrose	813	>1000
Clove Stem	827	>1000
Peach Kernal	831	>1000
Rapeseed	841	>1000
Teak	844	>1000
Jojoba	915	>1000
4-allyl anisole	925	>1000
Vetiver	934	>1000
Wheatgerm	943	>1000
Avocado	1002	>1000

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Ref: O3\_3/Chart 1  
Vyron 4.75mm Linalool

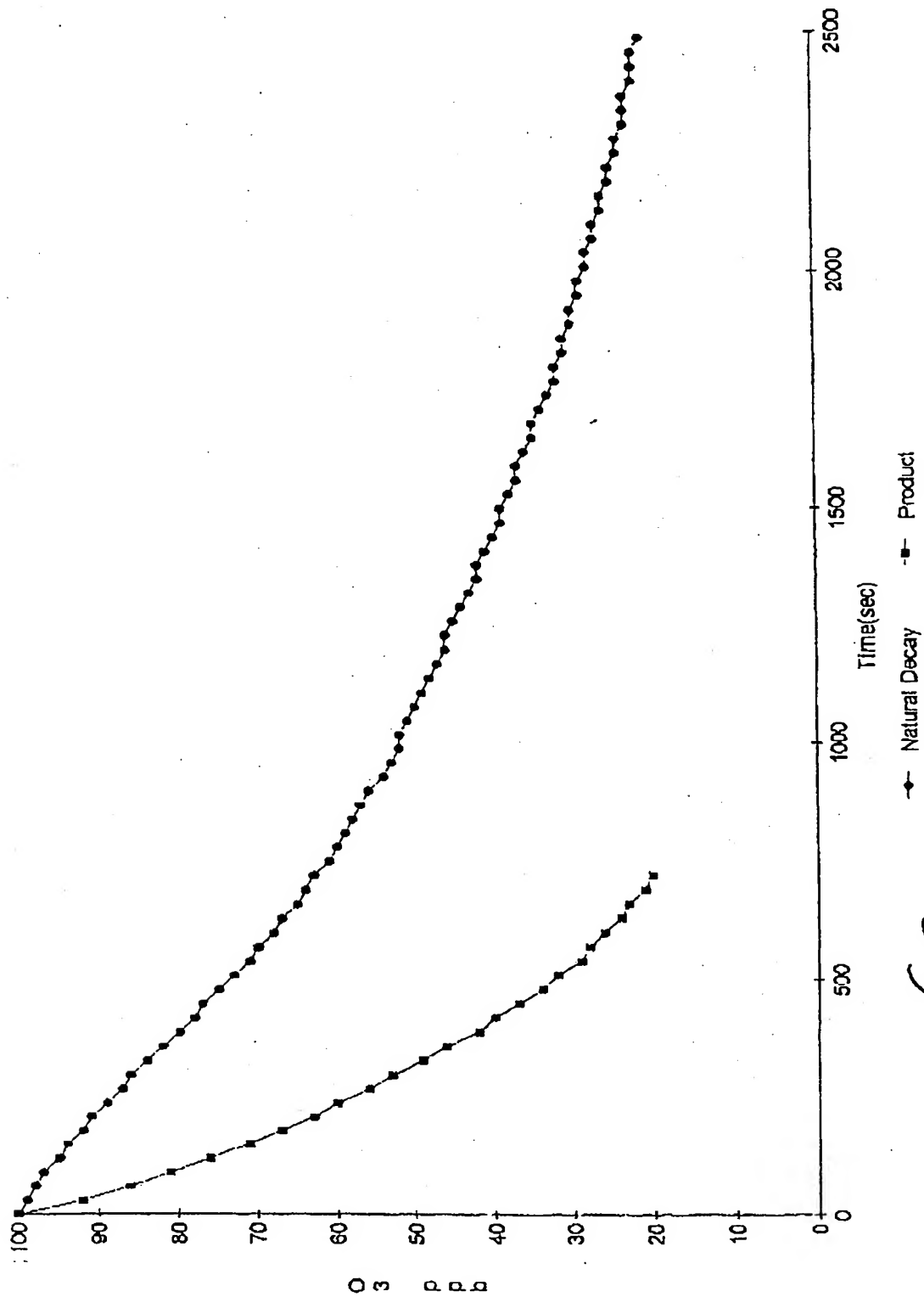


fig 3





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Ref: O3\_9/Chart2 18/1/99  
Linalool on Vyon E after 72 hours

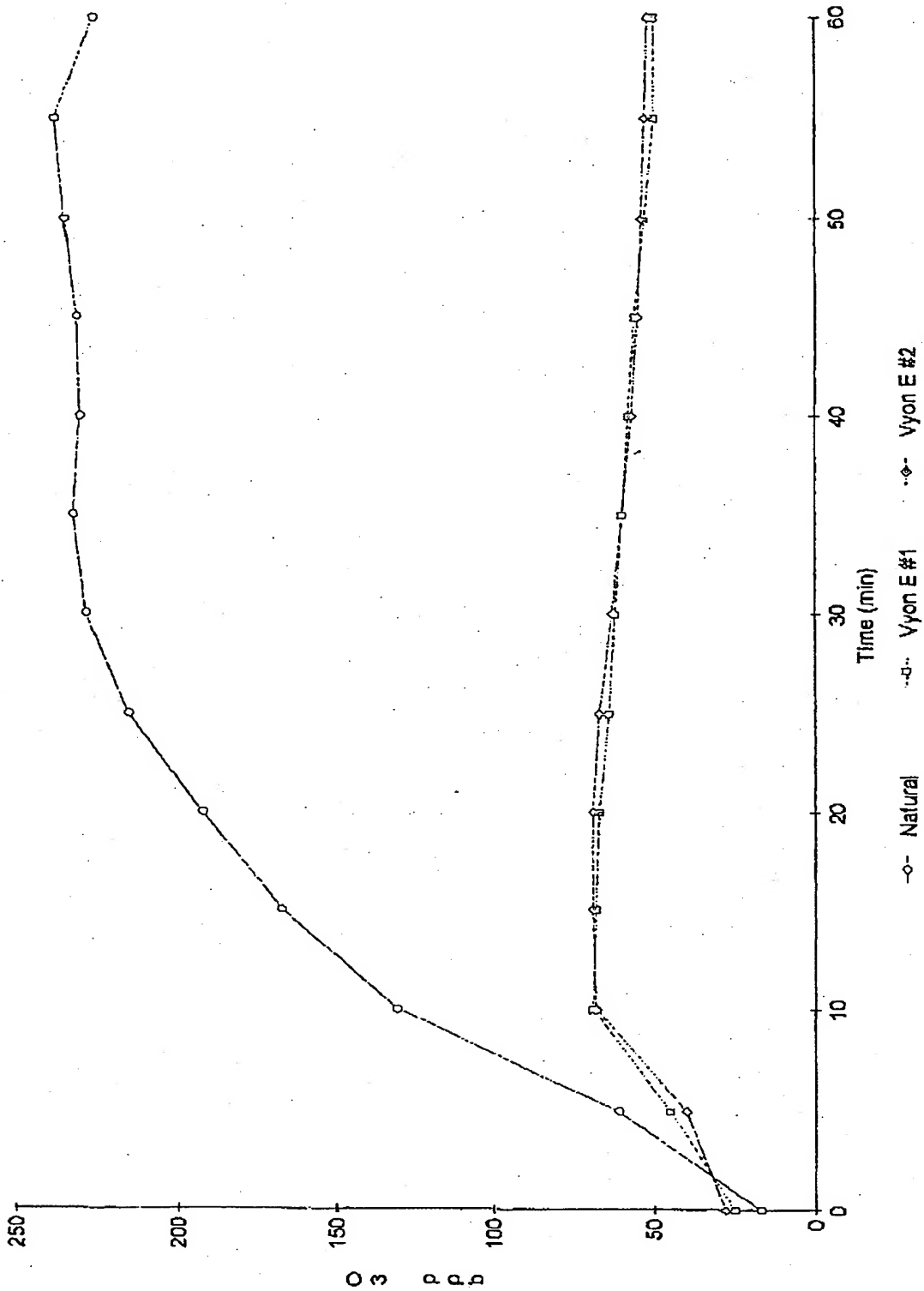


fig 4(a)



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Ref: O3\_9/Chart3 19/1/99  
Linalool on Vyon E after 96 hours

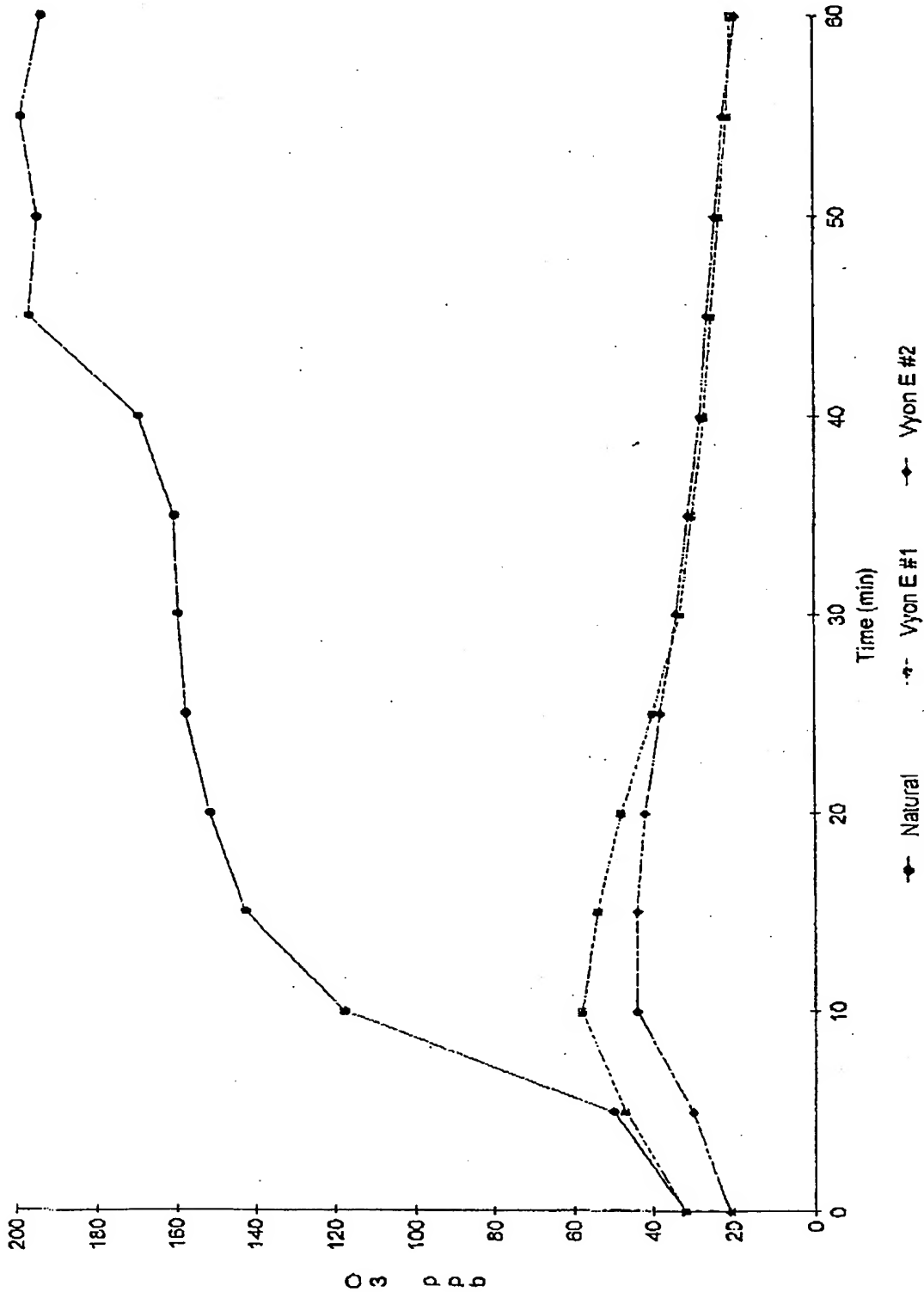


Fig 24 (h)



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Ref: O3\_9/Chart4 20/1/99

Linalool on Vyön E after 120 hours

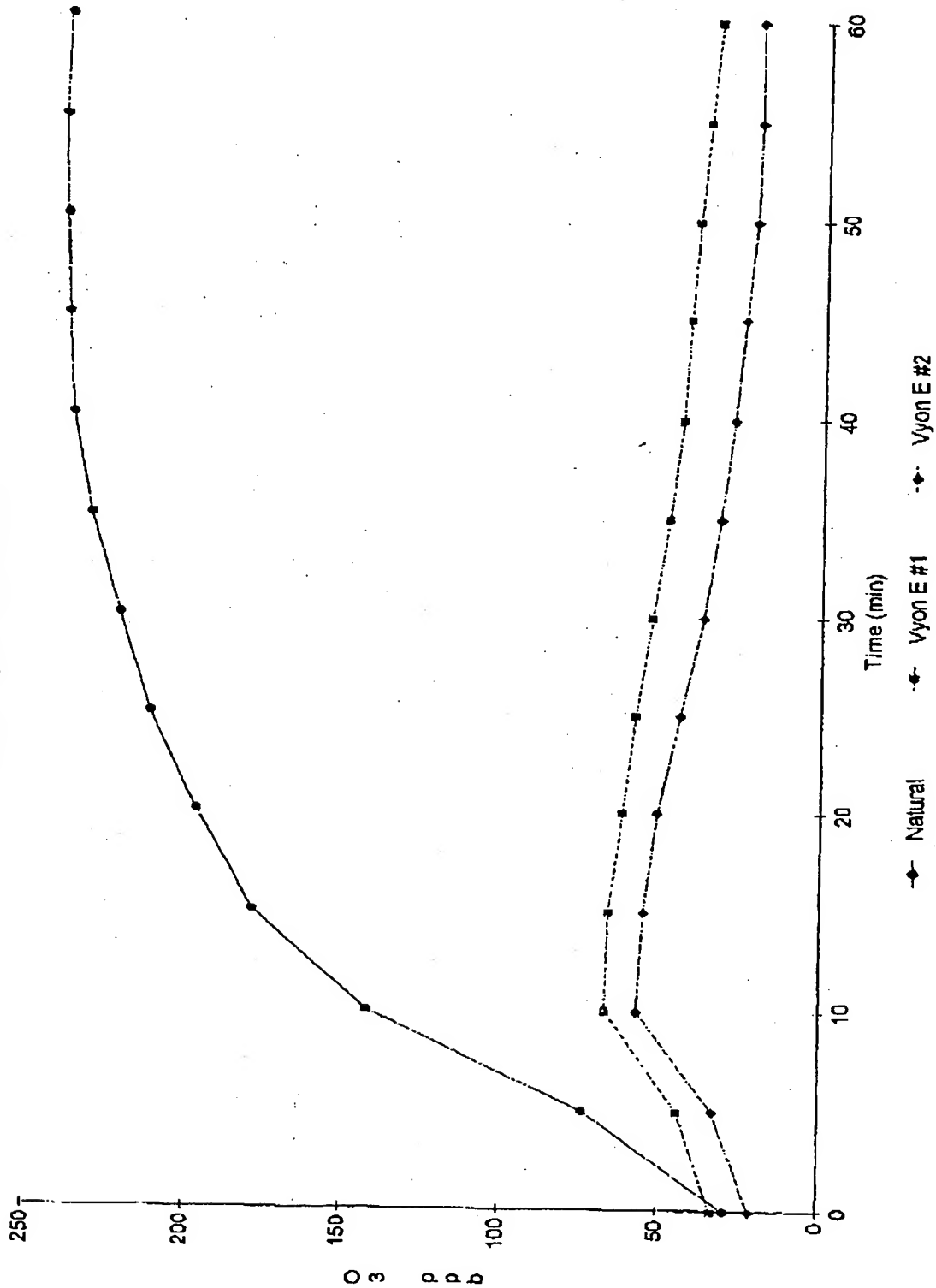


Fig 4(c)



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Ref: O3\_9/Chart5  
Linalol on Vyon E after 168 hours

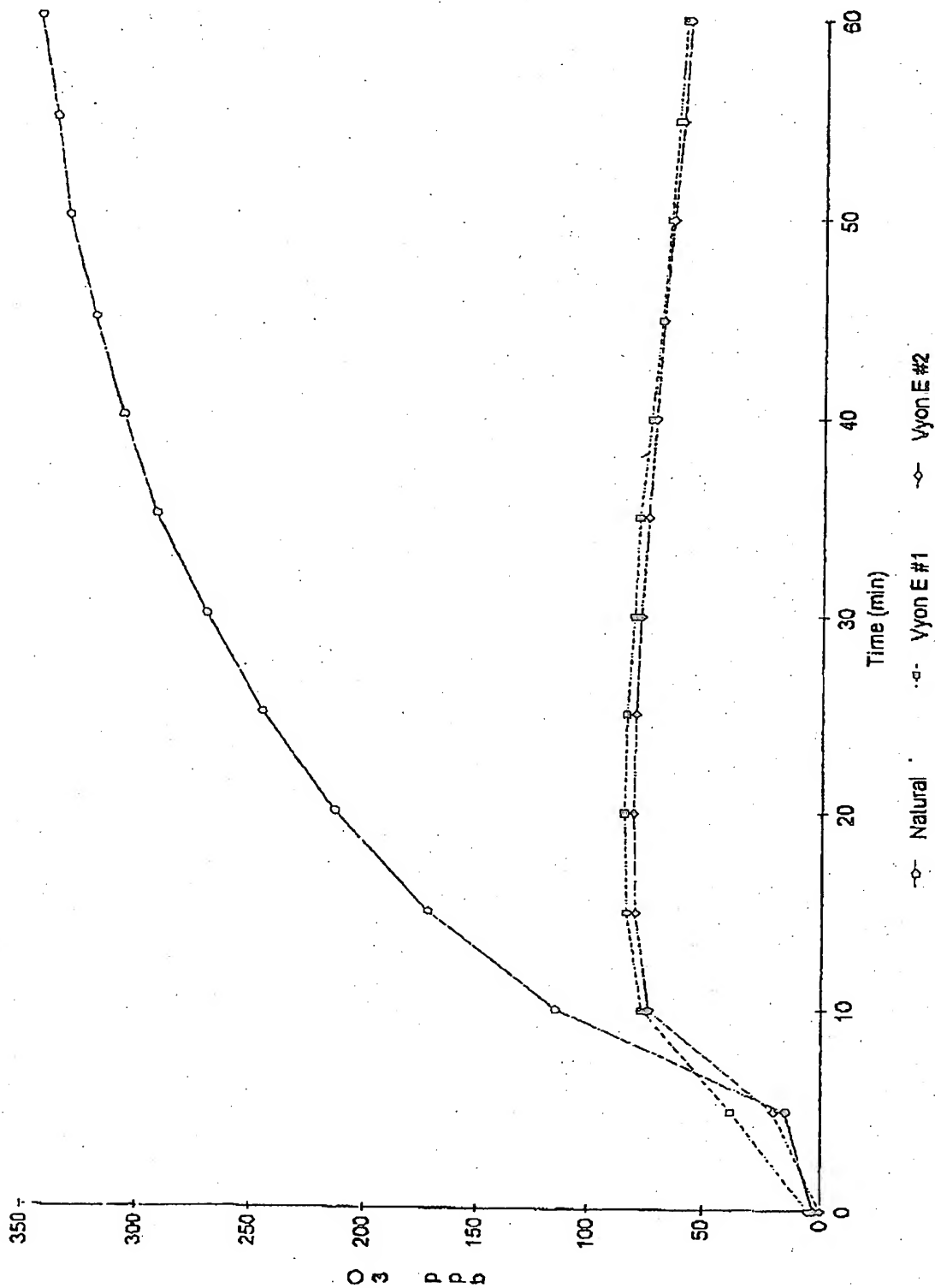


fig 4(a)

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